

WHAT IS CLAIMED IS:

1. A zoom lens apparatus, comprising:

a first optical lens group having a negative focal  
5 length arranged at a first position closest to a subject;

a second optical lens group having a positive focal  
length arranged at a second position second closest to the  
subject;

an aperture diaphragm which is disposed to a subject  
10 side of the second optical lens group closer to the subject  
in a manner such that the aperture diaphragm is movable  
integrally with the second optical lens group; and

a third optical lens group having a positive focal  
length arranged at a third position third closest to the  
15 subject,

wherein the first optical lens group, the second  
optical lens group, and the third optical lens group move in  
such a way that a distance between the first optical lens  
group and the second optical lens group is gradually  
20 decreased and a distance between the second optical lens  
group and the third optical lens group is gradually increased  
when a scaling of the zoom lens system is changed from a  
short focal length edge to a long focal length edge,

wherein the second optical lens group comprises a  
25 three-group and four-lens structure which comprises:

a positive lens arranged at a first sub-position

closest to the subject in the second optical lens group and such that a greater-curvature surface of the positive lens faces the subject;

5 a negative meniscus lens arranged at a second sub-position second closest to the subject in the second optical lens group and such that a concave of the negative meniscus lens faces the subject;

10 a positive meniscus lens conjoined with the negative meniscus lens and arranged at a third sub-position third closest to the subject in the second optical lens group; and

a positive lens arranged at a fourth sub-position fourth closest to the subject in the second optical lens group,

15 wherein the zoom lens system satisfies an inequality condition  $0.15 < (N_{22} - N_{23}) < 0.40$ , wherein  $N_{22}$  is a refractive index of the negative meniscus lens of the second optical lens group and  $N_{23}$  is a refractive index of the positive meniscus lens of the second optical lens group conjoined with  
20 the negative meniscus lens.

2. The zoom lens system according to Claim 1, wherein the zoom lens system satisfies an inequality condition  $25 < (v_{22} - v_{23}) < 50$ , wherein  $v_{22}$  is an Abbe number of the  
25 negative meniscus lens in the second optical lens group and  $v_{22}$  is an Abbe number of the positive meniscus lens conjoined

with the negative meniscus lens in the second optical lens group.

3. The zoom lens system according to Claim 1,  
5 wherein the zoom lens system satisfies an inequality condition  $1.40 < ((1/r_{21F}) + (1/r_{22F}) + (1/r_{22R})) < 2.20$ , wherein  $r_{21F}$  is a radius of curvature of a subject-side surface of the positive lens arranged at the first sub-position in the second optical lens group,  $r_{22F}$  is a radius of curvature of a  
10 subject-side surface of the negative meniscus lens arranged at the second sub-position in the second optical lens group,  $r_{22R}$  is a radius of curvature of a conjoined surface of the negative meniscus lens arranged at the second sub-position and the positive lens arranged at the third sub-position in  
15 the second optical lens group, and  $Y'$  is an image height.

4. The zoom lens system according to Claim 1,  
wherein the zoom lens system satisfies an inequality condition  $1.40 < (L_{PN}/L_2) < 0.70$ , wherein  $L_{PN}$  is a distance  
20 between a summit of the subject-side surface of the positive lens arranged at the first sub-position and a summit of the conjoined surface of the negative meniscus lens arranged at the second sub-position and the positive lens arranged at the third sub-position in the second optical lens group, and  $L_2$   
25 is a thickness of the second optical lens group in a direction of a light axis of the second optical lens group.

5. The zoom lens system according to Claim 1,  
wherein the conjoined surface of the negative meniscus lens  
arranged at the second sub-position and the positive lens  
5 arranged at the third sub-position has a radius of curvature  
which is greatest among lens surfaces included in the second  
optical lens group.

6. The zoom lens system according to Claim 1,  
10 wherein the subject-side surface of the positive lens  
arranged at the first sub-position in the second optical lens  
group and an image-side surface of the positive lens arranged  
at the fourth sub-position are aspherical.

15 7. A zoom lens apparatus, comprising:  
a first optical lens group having a negative focal  
length arranged at a first position closest to a subject;  
a second optical lens group having a positive focal  
length arranged at a second position second closest to the  
20 subject;  
an aperture diaphragm which is disposed to a subject  
side of the second optical lens group closer to the subject  
in a manner such that the aperture diaphragm is movable  
integrally with the second optical lens group; and  
25 a third optical lens group having a positive focal  
length arranged at a third position third closest to the

subject,

wherein the first optical lens group, the second optical lens group, and the third optical lens group move in such a way that a distance between the first optical lens group and the second optical lens group is gradually decreased and a distance between the second optical lens group and the third optical lens group is gradually increased when a scaling of the zoom lens system is changed from a short focal length edge to a long focal length edge,

wherein the second optical lens group comprises a three-group and four-lens structure which comprises:

a first positive lens arranged at a first sub-position closest to the subject in the second optical lens group and such that a greater-curvature surface of the positive lens faces the subject;

a negative meniscus lens arranged at a second sub-position second closest to the subject in the second optical lens group and such that a concave of the negative meniscus lens faces the subject;

a positive meniscus lens conjoined with the negative meniscus lens and arranged at a third sub-position third closest to the subject in the second optical lens group; and

a second positive lens arranged at a fourth sub-position fourth closest to the subject in the second optical lens group,

wherein the zoom lens system satisfies an inequality condition  $1.40 < ((1/r_{21F}) + (1/r_{22F}) + (1/r_{22R})) < 2.20$ , wherein  $r_{21F}$  is a radius of curvature of a subject-side surface of the first positive lens arranged at the first sub-position in the second optical lens group,  $r_{22F}$  is a radius of curvature of a subject-side surface of the negative meniscus lens arranged at the second sub-position in the second optical lens group,  $r_{22R}$  is a radius of curvature of a conjoined surface of the negative meniscus lens arranged at the second sub-position and the meniscus positive lens arranged at the third sub-position in the second optical lens group, and  $Y'$  is an image height.

8. A zoom lens apparatus, comprising:
- 15 a first optical lens group having a negative focal length arranged at a first position closest to a subject;
  - a second optical lens group having a positive focal length arranged at a second position second closest to the subject;
  - 20 an aperture diaphragm which is disposed to a subject side of the second optical lens group closer to the subject in a manner such that the aperture diaphragm is movable integrally with the second optical lens group; and
  - a third optical lens group having a positive focal length arranged at a third position third closest to the subject,

wherein the first optical lens group, the second optical lens group, and the third optical lens group move in such a way that a distance between the first optical lens group and the second optical lens group is gradually  
5 decreased and a distance between the second optical lens group and the third optical lens group is gradually increased when a scaling of the zoom lens system is changed from a short focal length edge to a long focal length edge,

wherein the second optical lens group comprises a  
10 three-group and four-lens structure which comprises:

a first positive lens arranged at a first sub-position closest to the subject in the second optical lens group and such that a greater-curvature surface of the first positive lens faces the subject;

15 a negative meniscus lens arranged at a second sub-position second closest to the subject in the second optical lens group and such that a concave of the negative meniscus lens faces the subject;

a positive meniscus lens conjoined with the  
20 negative meniscus lens and arranged at a third sub-position third closest to the subject in the second optical lens group; and

a second positive lens arranged at a fourth sub-position fourth closest to the subject in the second optical  
25 lens group,

wherein the zoom lens system satisfies an inequality

condition  $1.40 < (L_{PN}/L_2) < 0.70$ , wherein  $L_{PN}$  is a distance between a summit of the subject-side surface of the first positive lens arranged at the first sub-position and a summit of the conjoined surface of the negative meniscus lens arranged at the second sub-position and the meniscus positive lens arranged at the third sub-position in the second optical lens group, and  $L_2$  is a thickness of the second optical lens group in a direction of a light axis of the second optical lens group.

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9. A zoom lens apparatus, comprising:

a first optical lens group having a negative focal length arranged at a first position closest to a subject;

15 a second optical lens group having a positive focal length arranged at a second position second closest to the subject;

an aperture diaphragm which is disposed to a subject side of the second optical lens group closer to the subject in a manner such that the aperture diaphragm is movable integrally with the second optical lens group; and

20 a third optical lens group having a positive focal length arranged at a third position third closest to the subject,

wherein the first optical lens group, the second optical lens group, and the third optical lens group move in such a way that a distance between the first optical lens



group and the second optical lens group is gradually decreased and a distance between the second optical lens group and the third optical lens group is gradually increased when a scaling of the zoom lens system is changed from a  
5 short focal length edge to a long focal length edge,

wherein the second optical lens group comprises a three-group and four-lens structure which comprises:

a first positive lens arranged at a first sub-position closest to the subject in the second optical lens group and such that a greater-curvature surface of the first  
10 positive lens faces the subject;

a negative meniscus lens arranged at a second sub-position second closest to the subject in the second optical lens group and such that a concave of the negative  
15 meniscus lens faces the subject;

a positive meniscus lens conjoined with the negative meniscus lens and arranged at a third sub-position third closest to the subject in the second optical lens group; and

20 a second positive lens arranged at a fourth sub-position fourth closest to the subject in the second optical lens group,

wherein the conjoined surface of the negative meniscus lens arranged at the second sub-position and the positive  
25 lens arranged at the third sub-position has a radius of curvature which is greatest among lens surfaces included in

the second optical lens group.

10. A digital camera, comprising:

a zoom lens system which comprises:

5 a first optical lens group having a negative focal length arranged at a first position closest to a subject;

a second optical lens group having a positive focal length arranged at a second position second closest to  
10 the subject;

an aperture diaphragm which is disposed to a subject side of the second optical lens group closer to the subject in a manner such that the aperture diaphragm is movable integrally with the second optical lens group; and

15 a third optical lens group having a positive focal length arranged at a third position third closest to the subject,

wherein the first optical lens group, the second optical lens group, and the third optical lens group move in  
20 such a way that a distance between the first optical lens group and the second optical lens group is gradually decreased and a distance between the second optical lens group and the third optical lens group is gradually increased when a scaling of the zoom lens system is changed from a  
25 short focal length edge to a long focal length edge,

wherein the second optical lens group comprises a

three-group and four-lens structure which comprises:

a positive lens arranged at a first sub-position closest to the subject in the second optical lens group and such that a greater-curvature surface of the positive lens faces the subject;

a negative meniscus lens arranged at a second sub-position second closest to the subject in the second optical lens group and such that a concave of the negative meniscus lens faces the subject;

a positive meniscus lens conjoined with the negative meniscus lens and arranged at a third sub-position third closest to the subject in the second optical lens group; and

a positive lens arranged at a fourth sub-position fourth closest to the subject in the second optical lens group,

wherein the zoom lens system satisfies an inequality condition  $0.15 < (N_{22} - N_{23}) < 0.40$ , wherein  $N_{22}$  is a refractive index of the negative meniscus lens of the second optical lens group and  $N_{23}$  is a refractive index of the positive meniscus lens of the second optical lens group conjoined with the negative meniscus lens.

11. A personal digital assistance apparatus, comprising:

a zoom lens system which comprises:

a first optical lens group having a negative focal length arranged at a first position closest to a subject;

a second optical lens group having a positive  
5 focal length arranged at a second position second closest to the subject;

an aperture diaphragm which is disposed to a subject side of the second optical lens group closer to the subject in a manner such that the aperture diaphragm is  
10 movable integrally with the second optical lens group; and

a third optical lens group having a positive focal length arranged at a third position third closest to the subject,

wherein the first optical lens group, the second  
15 optical lens group, and the third optical lens group move in such a way that a distance between the first optical lens group and the second optical lens group is gradually decreased and a distance between the second optical lens group and the third optical lens group is gradually increased  
20 when a scaling of the zoom lens system is changed from a short focal length edge to a long focal length edge,

wherein the second optical lens group comprises a three-group and four-lens structure which comprises:

a positive lens arranged at a first sub-  
25 position closest to the subject in the second optical lens group and such that a greater-curvature surface of the

positive lens faces the subject;

a negative meniscus lens arranged at a second sub-position second closest to the subject in the second optical lens group and such that a concave of the negative meniscus lens faces the subject;

a positive meniscus lens conjoined with the negative meniscus lens and arranged at a third sub-position third closest to the subject in the second optical lens group; and

a positive lens arranged at a fourth sub-position fourth closest to the subject in the second optical lens group,

wherein the zoom lens system satisfies an inequality condition  $0.15 < (N_{22} - N_{23}) < 0.40$ , wherein  $N_{22}$  is a refractive index of the negative meniscus lens of the second optical lens group and  $N_{23}$  is a refractive index of the positive meniscus lens of the second optical lens group conjoined with the negative meniscus lens.

12. A zoom lens apparatus, comprising:

a first lens group having a negative focal length and arranged at a first position from a subject side;

a second lens group having a positive focal length and arranged at a second position from the subject side;

an aperture diaphragm arranged in front of a subject side surface of the second lens group and configured to move

together with the second lens group; and

a third lens group having a positive focal length and arranged at a third position from the subject side,

wherein at least the first and second lens groups move  
5 at a time the zoom lens apparatus changes a scaling from a short focal length edge to a long focal length edge such that a distance between the first and second lens group is decreased and that a distance between the second and third lens group is increased,

10 wherein the first lens group comprises:

a first negative meniscus lens having a concave lens surface facing an image plane and arranged at a first in-group position from the subject side;

a double-convex lens arranged at a second in-group  
15 position from the subject side; and

a double-concave lens conjoined with the double-concave lens and arranged at a third in-group position from the subject side.

20 13. The zoom lens apparatus according to Claim 12, wherein the first lens group further comprises a second negative meniscus lens arranged between the first negative meniscus lens and the double-concave lens.

25 14. The zoom lens apparatus according to Claim 13, wherein the zoom lens apparatus satisfies an inequality

condition  $0.20 < (D_4/L_1) < 0.40$ , wherein  $D_4$  is a distance on a light axis between an image side surface of the second negative meniscus lens in the first lens group and a subject side surface of the double-convex lens and  $L_1$  is a distance  
5 on a light axis between a subject side surface of the first negative meniscus lens and an image side surface of the double-concave lens in the first lens group.

15. The zoom lens apparatus according to Claim 13,  
10 wherein the zoom lens apparatus satisfies an inequality condition  $1.60 < (N_{14}) < 1.90$ , wherein  $D_{14}$  is a refractive index of the double-concave lens of the first lens group.

16. The zoom lens apparatus according to Claim 15,  
15 wherein the zoom lens apparatus satisfies inequality conditions  $-0.20 < (N_{13} - N_{14}) < 0.10$  and  $5 < (v_{14} - v_{13}) < 25$ , wherein  $N_{13}$  is a refractive index of the double-convex lens of the first lens group,  $N_{14}$  is a refractive index of the double-concave lens of the first lens group,  $v_{13}$  is an Abbe number of the  
20 double-convex lens of the first lens group, and  $v_{14}$  is an Abbe number of the double-concave lens of the first lens group.

17. The zoom lens apparatus according to Claim 13,  
25 wherein an image side surface of the second negative meniscus lens in the first lens group is aspheric.

18. The zoom lens apparatus according to Claim 13,  
wherein the second lens group comprises:

5 a first positive lens having a great-curvature surface  
facing the subject side and arranged at a first in-group  
position from the subject side;

a negative meniscus lens having a concave surface  
facing the image side and arranged at a second in-group  
position from the subject side;

10 a positive meniscus lens conjoined with the negative  
meniscus lens and arranged at a third in-group position from  
the subject side; and

a second positive lens arranged at a fourth in-group  
position from the subject side.

15

19. The zoom lens apparatus according to Claim 18,  
wherein the zoom lens apparatus satisfies inequality  
conditions  $-0.15 < (N_{22} - N_{23}) < 0.40$  and  $25 < (v_{23} - v_{22}) < 50$ , wherein  $N_{22}$   
is a refractive index of the negative meniscus lens of the  
20 second lens group,  $N_{23}$  is a refractive index of the positive  
meniscus lens conjoined with the negative meniscus lens in  
the second lens group,  $v_{22}$  is an Abbe number of the negative  
meniscus lens of the second lens group, and  $v_{23}$  is an Abbe  
number of the positive meniscus lens conjoined with the  
25 negative meniscus in the first lens group.



20. The zoom lens apparatus according to Claim 18,  
wherein the zoom lens apparatus satisfies an inequality  
condition  $1.40 < \{ (1/r_{21F}) + (1/r_{22F}) + (1/r_{22R}) \} * Y' < 2.20$ , wherein  $r_{21F}$   
is a curvature radius of a subject side surface of the first  
5 positive lens in the second lens group,  $r_{22F}$  is a curvature  
radius of a subject side surface of the negative meniscus  
lens in the second lens group,  $r_{22R}$  is a curvature radius of a  
conjoined surface of the negative meniscus lens and the  
positive meniscus lens in the second lens group, and  $Y'$  is an  
10 image height.

21. The zoom lens apparatus according to Claim 18,  
wherein the zoom lens apparatus satisfies an inequality  
condition  $0.40 < (L_{PN}/L_2) < 0.70$ , wherein  $L_{PN}$  is a distance on a  
15 light axis between the a subject side surface of the first  
positive lens and a conjoined surface of the negative  
meniscus lens and the positive meniscus lens in the second  
lens group, and  $L_2$  is a distance on a light axis between the  
subject side surface of the first positive lens and an image  
20 side surface of the second positive lens in the second lens  
group.

22. The zoom lens apparatus according to Claim 18,  
wherein a curvature of a conjoined surface of the negative  
25 meniscus lens and the positive meniscus lens in the second  
lens group is a greatest curvature in the second lens group.

23. The zoom lens apparatus according to Claim 18,  
wherein a subject side surface of the first positive lens and  
an image side surface of the second positive lens are  
5 aspheric.

24. The zoom lens apparatus according to Claim 12,  
wherein the second lens group comprises:  
at least one negative lens; and  
10 at least three positive lenses.

25. The zoom lens apparatus according to Claim 24,  
wherein the first lens group further comprises a second  
negative meniscus lens arranged between the first negative  
15 meniscus lens and the double-concave lens.

26. The zoom lens apparatus according to Claim 24,  
wherein the at-least-one negative lens is a negative meniscus  
lens having a concave surface facing the image side and  
20 arranged at a second in-group position from the subject side,  
and the at-least-one positive lenses are a first positive  
lens having a great-curvature surface facing the subject side  
and arranged at a first in-group position from the subject  
side, a positive meniscus lens conjoined with the negative  
25 meniscus lens arranged at a third in-group position from the  
subject side, and a second positive lens arranged at a fourth

in-group position from the subject side.

27. A digital camera comprising:

a zoom lens apparatus which comprises:

5 a first lens group having a negative focal length and arranged at a first position from a subject side;

a second lens group having a positive focal length and arranged at a second position from the subject side;

10 an aperture diaphragm arranged in front of a subject side surface of the second lens group and configured to move together with the second lens group; and

a third lens group having a positive focal length and arranged at a third position from the subject side,

15 wherein at least the first and second lens groups move at a time the zoom lens apparatus changes a scaling from a short focal length edge to a long focal length edge such that a distance between the first and second lens group is decreased and that a distance between the second and third lens group is increased,

20

wherein the first lens group comprises:

a first negative meniscus lens having a concave lens surface facing an image plane and arranged at a first in-group position from the subject side;

25 a double-convex lens arranged at a second in-group position from the subject side; and

a double-concave lens conjoined with the double-concave lens and arranged at a third in-group position from the subject side.

5           28.    A personal digital assistance apparatus,  
comprising:

          a zoom lens apparatus which comprises:

          a first lens group having a negative focal length  
and arranged at a first position from a subject side;

10           a second lens group having a positive focal  
length and arranged at a second position from the subject  
side;

          an aperture diaphragm arranged in front of a  
subject side surface of the second lens group and configured  
15 to move together with the second lens group; and

          a third lens group having a positive focal length  
and arranged at a third position from the subject side,

          wherein at least the first and second lens groups move  
at a time the zoom lens apparatus changes a scaling from a  
20 short focal length edge to a long focal length edge such that  
a distance between the first and second lens group is  
decreased and that a distance between the second and third  
lens group is increased,

          wherein the first lens group comprises:

25           a first negative meniscus lens having a concave  
lens surface facing an image plane and arranged at a first

in-group position from the subject side;

a double-convex lens arranged at a second in-group position from the subject side; and

a double-concave lens conjoined with the double-  
5 concave lens and arranged at a third in-group position from  
the subject side..